Faculty Working Papers

THE MARKET MODEL: POTENTIAL FOR ERROR

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with Officer's. However, the "risk premium" variable (one not considered by Officer) shows significant positive correlations with the volatility variable in every subperiod.

Effect of Institutional Trading. Legislation restricting the freedom of large institutions to actively trade in the capital markets is a real possibility when the belief exists that increased institutional trading in the stock market leads to an increase in market return volatility. The empirical evidence provided in this study, however, does not indicate that institutions are the cause of any increase in market return volatility. In fact, the significant negative relationships indicate that an increase in institutional trading is related to a decline in market return volatility. Thus, it seems that institutional trading provides liquidity for the total market. In addition, we found significant positive correlations between institution purchases and sales which implies that institutions are providing liquidity for one another.

Given such conclusions, there is no justification for attempting to restrict trading by financial institutions. In fact, such restrictions could lead to an increase in market return volatility because restrictions would, by definition, reduce institutional trading activity and the liquidity available for all market participants.

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AN INVESTORS LOSS FUNCTION FOR EARNINGS FORECASTS WITH AN EMPIRICAL APPLICATION

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Summary:

This paper deals with an investor loss function for earnings forecasts. Specifically we develop a theoretical framework that measures loss in the context of the problem of resource allocation under uncertainty. The framework maps a set of forecasts into an expected return. This expected return is compared to that return which could be expected given perfect knowledge of future earnings and the resulting difference measures the investor's loss. Some empirical results are given.

This paper deals with an investor loss function for earnings forecasts. Specifically we develop a theoretical framework that measures loss in the context of the problem of resource allocation under uncertainty. The framework maps a set of forecasts into an expected return. This expected return is compared to that return which could be expected given perfect knowledge of future earnings and the resulting difference measures the investor's loss.

The need for a loss function arises from the need of investors to assess the value of alternative sources of forecasts. In addition empirical research studies have often compared various forecast models. The typical approach has been to compare forecast <u>accuracy</u> or <u>dispersion</u>. This approach, however, is limited. For example Foster [1977, p. 10] stated "It is important to recognize that our measures of dispersion are essentially surrogate criteria for evaluating alternative forecasting models. A more complete analysis would specify the loss function in a specific decision context." In addition Gonedes et al [1976, p. 94] wrote, "There is a more fundamental deficiency in these prediction performance studies.... Specifically they are not based upon any explicit theoretical structure that connects their frameworks to resource allocation under uncertainty."

The purpose of the present study is to develop a theoretical framework to overcome these limitations. This framework takes the form of an investor loss function (henceforth ILF). A secondary purpose is to empirically apply the ILF for purposes of comparing forecasts generated from several models that have recently been employed in the literature.

The paper is in four parts. Part one discusses some of the issues associated with an ILF, part two presents an operational form of the ILF, part three is an empirical application and part four contains summary and conclusions.

BACKGROUND ISSUES

An important result of research on the information content of accounting earnings is that ex ante knowledge of annual earnings can provide an opportunity for an investor to earn an abnormal return. For example, Ball and Brown [1968] reported that if one were to know the sign of the unexpected annual earnings change 12 months in advance it would be possible to earn a 7% abnormal return via a simple trading rule. These findings pose some interesting questions with respect to earnings forecasts.

1) If the market is efficient, then we wouldn't expect a forecast model to enable an individual to earn an abnormal return via utilizing only publically available information.

2) If the expectation in (1) is correct, then from the individual investors standpoint the problem of comparing various sets of forecasts might become irrelevant. One could expect to earn no better than the risk conditioned rate of return since the risk-return relationship should not depend on the portfolio selection process.

3) Looking at (2) from another side, we would not expect a return less than the risk conditioned return via the same reasoning.

Given the above reasoning, it might seem that investors would only be concerned with constructing minimum variance portfolios and would not be concerned with using earnings forecasts in their decision models. Research, however, points to the exact opposite. For example, Nordby [1973] found that 99% of responding analysts claimed that they use earnings forecasts in their decision making process.

What then accounts for the extensive use of forecasts in practice? The answer seemingly must be one of two things:

(1) Some individuals do earn an abnormal return and the market is not efficient.

(2) Some individuals think that they can earn an abnormal return, but the market is efficient and they are possibly irrationally allocating resources for purposes of obtaining forecasts.

Research and reasoning can be used to support both (1) and (2). A large amount of research has been conducted which favors efficiency. On the other hand there is evidence which is not consistent with efficiency. A good example of this is the Value Line Investment survey. Black [1973] found reasonably strong evidence that the survey is able to predict returns of securities in a way that cannot be accounted for by differences in risk. (Note that the survey relies heavily on a determination of "earnings momentum".) In addition, Joy et al [1977, p. 207] presented evidence that, "...the information contained in quarterly earnings was not fully impounded into stock prices at the time of announcement."

It is not the purpose of the present paper to take a position on efficiency or lack of efficiency in the market. However it must be noted that the theory of market efficiency does not explain the empirically observed behavior of users of earnings forecasts. An alternative framework which might explain such behavior is that of Grossman and Stiglitz[1] [1976] who pointed out that costless information is not only sufficient for market efficiency but <u>necessary as well</u>. Their alternative is summarized (p. 218):

> In the structure we have developed, the market never fully adjusts. Prices never fully reflect all the information possessed by the informed individuals. Capital markets are not efficient, but the difference is just enough to provide the revenue required to compensate the informed for purchasing the information.

Note that this framework allows for the possibility that there is a value of gathering information and therefore a corresponding loss for gathering

information which is less than optimal. Stated differently, an "abnormal" return must be earned to cover the cost of information production and to the degree that an abnormal return is not earned there is, in a sense, a loss. It is this loss that is the focus of the study.

If the market is assumed to be efficient and the market's earnings expectation model is assumed to be optimal, then one might gauge the usefulness of a given forecast method by measuring the abnormal returns associated with an investment strategy based on an ex ante knowledge of the forecast error (i.e., unexpected earnings) of the given model. This statement is elaborated on by Brown and Kennelly [1972, p. 404]:

> This experimental design permits a direct comparison between alternative forecasting rules....The...contention is based on the hypothesis (and evidence) that the stock market is "both efficient and unbiased in that, if information is useful in forming capital asset prices, then the market will adjust asset prices to that information quickly and without leaving any opportunity for further abnormal gain" (Ball and Brown, 1968). There is, then a presumption that the consensus of the market reflects, at any point, an estimate of future EPS which is the best possible from generally available data. Since the abnormal rate of return measures the extent to which the market has reacted to errors in its previous expectations, the abnormal rate of return can be used to assess the predictive accuracy of any device which attempts to forecast a number that is relevant to investors. To our knowledge, Ball and Brown (1968) were the first to make use of this fact.

This basic type of reasoning can be used to derive several types of empirical tests all based on different sets of assumptions as listed below.

Category	Assumptions	Test
1	A) Efficient market B) Earnings has information content	Compare Prediction models on ability to approximate assumed optimal market prediction model
2	A) Efficient market B) Given prediction model approximates market model	Information content
3	A) Efficient market	Joint test of information content and prediction model

Most of the accounting research has fallen in one of the above three categories. For example Foster's [1977] study on quarterly accounting data falls into category 1 while Ball and Brown [1968] and Brown and Kennelly [1972] among many others fall into category 2. It can be argued also that categories 1 and 2 are subsumed under category 3 which reduces to the first two cases to the degree that the assumptions are correct. In the present study we develop a methodology (ILF) for comparing prediction methods which do not rely on any of the Table 1 assumptions. Instead we assume that there exists some market expectation (prediction) for earnings (not necessarily optimal) and a corresponding unanticipated earnings figure. From an investor's standpoint it is of interest to predict this unanticipated change in earnings, since given knowledge of the unanticipated earnings change, he can formulate an investment strategy which will produce an abnormal return as measured by the market model. <u>We define the investor's loss to be the difference between the return that he would earn given the perfect knowledge of the</u>

unexpected earnings and that return which he would earn based on utilizing his prediction of the unanticipated earnings number. This definition is operationalized below and applied to a comparison of several forecast methods found in the literature.

It should be emphasized that in developing the loss function we are not concerned with market efficiency per se but rather an individual investor's perceptions with respect to market efficiency. In particular we assume that the investor believes that there is a possibility of earning a return higher than predicted by the Sharp-Lintner [1964, 1965] capital asset pricing model. As pointed out previously, unless this assumption holds, there is no private value of the earnings forecast based on publicly available information. If there is no private value, then from the individual's standpoint the process of comparing forecasts is dubious. It is also pointed out that the loss function derived in this paper does not depend on the need to compare forecast methods but simply specifies the loss associated with different forecast sources. If there is no need to compare forecast methods, then all forecast methods should have equal loss. This is an empirical question.

OPERATIONALIZATION OF THE ILF

In order to use the ILF, it is first necessary to operationally define a market expectation model. In this study we use the cross-sectional model employed by Ball and Brown [1968] which regresses individual firms' earnings changes on market earnings changes. We use this model since Ball and Brown observed that ex ante knowledge of its residuals made it possible for an investor to earn a 7% abnormal return.

To facilitate operationalization of the loss function we make the following definitions:

(1) F_{it_0}

(2) $E(A_{it}) = \alpha_{1i} + b_{1i} \sum_{\substack{j=1 \\ i \neq j}}^{N} A_{jt}$

(3) $E(F_{it_0}) = \alpha_{1i} + b_{1i} \left(\sum_{i \neq j}^{N} F_{jt_0} \right)$

(4) $E[\ln(1 + R_{it} - R_{ft})] = b_{2i} \ln(1 + R_{mt} - R_{ft})$

Where:

(A) F_{it_0} represents the investor's expectation of earnings change for firm i and period t. This expectation could be the result of intuition, statistical modeling or judgmental opinion.

(B) (2) is an empirical description of the relationship between market and firm earnings changes. The coefficients α_{1i} and b_{1i} are assumed to be known by investor. Note that the investor is assumed to use the same coefficients in (3). Also the subscript t denotes time previous to t_o. (In the empirical application, α_{1i} and b_{1i} are estimated by regression on previous years' data.)

(C) $E(F_{it_0})$ represents the investor's expectation of earnings changes (A_{it}) for firm i in period t_0 conditioned upon his expectation of the market earnings period t_0. Since this depends on F_{jt_0} (which is ex ante), it is ex ante.

(D) $E(R_{it})$ is the Sharp-Lintner [1964, 1965] capital asset pricing model where R_{it} represents the return on asset i in period t, R_{mt} represents the market return in period t and R_f is the risk free rate of return.

Given the above definitions we can define the investor's anticipation of the unexpected change in earnings. It is this unexpected change which Ball and Brown [1968] found to enable one to earn an abnormal return when known in advance. We proceed to define the investor's anticipation of the unexpected changes in earnings subtracting (2) from (1):

(5) $a_{it_0} = F_{it_0} - E(F_{it_0})$

When a_{it_0} is greater than zero, then the investor expects a positive unexpected change in earnings. When a_{it_0} is less than zero, a negative unexpected change is anticipated. This is consistent with the Ball and Brown market conditioned definition of unanticipated change in earnings except it is based on predicted earnings as opposed to actual earnings.

Given that a_{it_0} is positive (negative), the investor would be expected to buy long (sell short) in asset i. Also to the degree that his expectations are correct, he will earn an abnormal return which will be denoted notationally as AR_F. Similarly let AR_{PF} represent the abnormal return assuming that investor has perfect knowledge of the future earnings (i.e., his predictions of all firms are perfectly accurate). Then define the investors loss function (ILF) as

(6) $ILF = AR_{PF} - AR_F$

Where ILF has the intuitive interpretation as being the loss incurred from not having perfect forecasts. The minimum expected value is expected to be 0 in the case of having perfect forecasts, and equal to the abnormal return of having perfect forecasts in the case of having useless forecasts.

EMPIRICAL APPLICATION

Forecast Models

The empirical results of this study focus on the ability of several statistical models to predict annual EPS from quarterly EPS. This purpose has been suggested by the Financial Accounting Standards Board in the

discussion memorandum, Interim Financial Accounting and Reporting (FASB, 1978). In addition there has been a considerable amount of research done on the predictive ability of models using quarterly EPS (e.g., Lorek, 1979; Foster, 1977; Brown and Rozeff, 1978).

We focus on several models that have been given considerable attention with respect to their ability to represent the time series of quarterly EPS. These are

1) a seasonally and consecutively differenced first order and seasonal moving average model [Griffin, 1977; Watts, 1975]
2) a seasonally differenced first order autoregression model with a constant drift term[2] [Foster, 1977]
3) a seasonally differenced first order autoregressive and seasonal moving average model [Brown and Rozeff, 1978]
4) firm identified and estimated Box-Jenkins models.

In the Box-Jenkins notation the first three are referred to as (0,1,1) x (0,1,1), (1,0,0) x (0,1,0) and (1,0,0) x (0,1,1), respectively. For the remainder of the study these are referred to as the GW, F, and BR models.

Sample Selection

Data pertaining to the sample of 264 firms was obtained from the Compustat quarterly and CRSP monthly tapes. For a firm to be included in the sample, it was required to have no missing EPS or returns data for the 64 consecutive quarters beginning with the first quarter of 1962. This provided a sample period from 1962 through 1977. The EPS number used was primary earnings per share excluding extraordinary items and discontinued operations adjusted for capital changes. The return figure selected from CRSP included both a dividend and price component.

Application of the Forecasting Models

For purposes of assessing the ILF's of the 4 forecast methods, the years of 1976 and 1977 were used as holdout periods. Therefore the 264 series were each modeled 8 times, once for each method using pre 1976 data (56 quarters in the base period) and again for each method (60 quarters in the base period) using all pre 1977 data. The result was that each model made predictions for the 4 quarters in 1976 and the 4 quarters of 1977. These quarterly forecasts were aggregated within each year to form annual forecasts. These forecasts represent $F_{i,t}$ in (1) above.

Next the coefficients α_{1i} and β_{1i} in (3) were estimated for each firm. The procedure was done for each hold out year and was based on all data prior to the holdout year. The market index was computed by summing all of the sample firms' EPS except the one for which the model was being estimated. The residuals of the models were tested for autocorrelation and the null hypothesis of no autocorrelation was rejected for only 8 firms which was attributed to chance.

The α_i and β_i coefficients were then applied to compute the investors anticipation of the market conditioned EPS in (2) and finally the anticipation of the unexpected earnings change in (5).

Application of the Market Model

The market model (4) was estimated (in log form) for each firm and for each of the two years. The estimation included data in the 5 years preceeding the holdout year. The residuals from these models when applied to the two holdout years constitute abnormal returns. The market index used was the equally weighted index containing the dividend-price returns of all firms except for the one being estimated.

Empirical Results

The loss for each forecast method was calculated by computing the annual cummulative abnormal return (CAR) associated with each forecast method and subtracting this from the CAR associated on an investment strategy based on ex ante knowledge of the actual EPS. The CARs were computed by assuming a long investment given a_{it_0} in (5) was positive (henceforth CAR+) and a short investment given that a_{it_0} was negative (henceforth CAR-).

Table 1 gives the cummulative abnormal residuals for the 4 forecast methods and actual EPS, for the 12 months prior to and including the earnings announcement date. Quick inspection reveals that only the GW (for the year 1977) and the actuals (for the year 1977) demonstrate a strong apparent pattern of abnormal return. Surprising, however, is that in 1976 the actuals exhibited virtually no net abnormal return. In fact the 1976 actual CAR+ as a whole (i.e., month 0) is of the wrong sign though nearly equal to 0.

[Table 1 here]

Table 2 presents the loss for each of the 4 methods. Note that in all cases the loss is positive with the smallest overall loss being associated with the GW method and the largest loss being associated with the BR. Table 3 gives the rankings of each method where 1 denotes the smallest loss, etc. Note that the GW model loss dominates (is smallest) in both years.

[Tables 2 and 3 here]

In order to assess the significance of the differences between the losses in Table 2, a weighted analysis of variance was done using a model

containing 3 factors: firm (264 levels), method (4 levels) and year (2 levels). The dependent variable was taken to be 1 in the event that a decision to invest (based on the sign of a_{it_0} in (5)) for a given firm, year and method led to a positive market return and 0 otherwise.

To provide useful descriptive statistics and a feel for the meaning of the weighted ANOVA, the unweighted ANOVA cell means are presented in Table 4. These can be interpreted as the percentage of times that a given method makes the correct decision (i.e., earns a positive return), and the larger the percentage, the more that method would be preferred. Note, however, that this percentage measure ignores the magnitude of the individual decision outcomes (i.e., the magnitude of the abnormal return). For this reason a weighted ANOVA was done where the means were computed on a weighted basis using the absolute value of the CARs as weights. The results are presented in Table 5.

[Tables 4 and 5 here]

Note that the mean rankings are consistent with those in Table 3 and 4 and also that the effect of method is highly significant, implying that the means for the 4 methods are not equal.

Since the method effect was found to be significant, a posteriori pairwise tests for equality of means were made using Scheffe's paired comparison test[3] [Winer, 1971]. These results are given in Table 6 and indicate that all possible pairs are significantly different from each other with the exception of BR vs BJ.

[Table 6 here]

An Alternative Basis for Comparing Methods

An alternative way to compare methods would be to perform an identical ANOVA as above except let the dependent equal 1 when a given method produces the same investment decision as would have been made had the forecasted EPS been perfectly accurate (and 0 otherwise). This approach evaluates each forecast set on the basis of how frequently the decisions resulting from that set agree with decisions which would have been made if each forecast in the set was perfectly accurate. The ANOVA results of using this approach and the ANOVA results from the first definition of the dependent variable should be consistent to the degree that ex ante knowledge of the actual produces the best investment decision. If ex ante knowledge of the actual always produces the best investing decision, then both definitions are exactly the same. Also it seems reasonable to use definition two since the focus of forecasting is predicting the actual EPS and therefore a method which performs better in this respect might be preferred. Of course the acid test of how well a method performs must relate the decision to the return (definition one) but in any given year statistical variation might cause a given method to be ranked low under definition one but not under definition two. Therefore one might prefer to adopt a method under these circumstances on the assumption that it gives better predictions of actual EPS and therefore will be likely to be superior under definition one in future years.

Table 7 presents the weighted ANOVA results for definition two. Again the effect of method is highly significant. Note that the ranks

[Table 7 here]

are essentially the same with the exception that BJ and BR exchanged places, which does not seem unreasonable since they were not significantly different in the first set of paired difference tests.

Table 8 presents the paired tests for definition two. All differences are significant with the exception of GW vs. F. Again GW and F have significantly higher means than BJ and BR.

[Table 8 here]

Summary and Conclusions

Previous research involving comparisons among forecast methods has typically relied on various error metrics. In the present study an alternative approach has been taken, namely comparing forecast methods based on the outcomes of investment decisions which depend on earnings forecasts. In particular an investor's loss was defined as: <u>The difference between the return which would be earned given perfect knowledge of the unexpected earnings and return which would be earned based on utilization of a prediction of the unexpected earnings number</u>.

Several forecast models were examined based on their observed loss. The results indicated that the models studied by Foster ((1,0,0) x (0,1,0)) and Griffin and Watts ((0,1,1) x (0,1,1)) performed better than those of Brown and Rozeff ((1,0,0) x (0,1,1)) and individually identified Box-Jenkins models.

TABLE 1

TABLE 1

Cumulative Abnormal Residuals for Prediction Methods and Actual Earnings

	Month*	BJ 1977	BJ 1978	BR (1,0,0) x (0,1,1) 1977	BR (1,0,0) x (0,1,1) 1978	F (1,0,0) x (0,1,0) 1977	F (1,0,0) x (0,1,0) 1978	GW (0,1,1) x (0,1,1) 1977	GW (0,1,1) x (0,1,1) 1978	Actual 1977	Actual 1978
CAR+	-11	-.00786	.00378	.00281	.00352	.00183	.00419	-.00345	.00602	-.00334	.00201
	-10	-.00977	-.01045	-.00219	-.00703	-.00078	-.00430	-.01023	.00121	-.00244	.00630
	-9	-.01577	-.01657	-.00731	-.00620	-.00407	-.00329	-.00819	.00670	-.00067	.01672
	-8	-.01088	-.01241	-.00414	.00239	-.00213	.00350	-.00339	.01703	.00415	.02713
	-7	-.00756	-.01480	-.00094	-.00504	-.00141	.00189	.00035	.01543	.00422	.02593
	-6	-.02129	-.00522	-.01654	-.00133	-.01621	.01321	-.00891	.02399	-.00324	.03550
	-5	-.02542	-.00101	-.02434	-.00240	-.02160	.01594	-.00919	.02418	-.00300	.03771
	-4	-.03002	-.00491	-.03051	-.00549	-.02649	.01287	-.01411	.02587	-.00382	.04212
	-3	-.01668	.00064	-.02176	-.00144	-.01467	.01868	-.00394	.03603	.00373	.05116
	-2	-.02428	.00257	-.03455	-.00069	-.02226	.01743	-.01603	.03511	-.00248	.04980
	-1	-.02512	.00216	-.03769	.00407	-.02423	.02442	-.01782	.03550	.00057	.05123
	0	-.03862	.00722	-.04962	.00807	-.03166	.02860	-.02152	.04549	-.00030	.06009
CAR-	-11	-.00656	-.00143	-.01639	-.00093	-.01861	-.00119	-.01277	-.00533	-.01713	-.00073
	-10	-.00774	.00754	-.01468	.00373	-.01874	.00116	-.00631	-.00422	-.02496	-.01580
	-9	.00167	.02121	-.00541	.01055	-.00919	.00754	-.00349	-.00192	-.02137	-.02412
	-8	-.00153	.02095	-.00737	.00686	-.01052	.00582	-.00949	-.01103	-.03189	-.03901
	-7	-.00670	.01161	-.01280	.00208	-.01435	-.00338	-.01838	-.02273	-.03670	-.05441
	-6	-.00424	.00671	-.00790	.00284	-.00676	-.00805	-.01682	-.02905	-.01512	-.06700
	-5	.00182	-.00014	.00202	.00097	.00329	-.02167	-.02189	-.03277	-.01070	-.07582
	-4	-.00140	.00612	.00030	.00600	.00075	-.00806	-.01514	-.03185	-.04251	-.08048
	-3	.00510	.00934	.01076	.01059	.00760	-.00480	-.00632	-.03507	-.02744	-.08538
	-2	-.00043	.00028	.01013	.00310	.00254	-.01039	-.00429	-.04251	-.03461	-.09383
	-1	.00626	.00170	.01928	.00014	.01243	-.01459	.00656	-.04179	-.03087	-.09506
	0	.01417	.00376	.02668	.00325	.01758	-.00157	.00737	-.04572	-.03548	-.10207
C** O M P O S I T E	-11	-.00005	.00257	.00986	.00211	.00920	.00246	.00300	.00572	.00232	.00158
	-10	-.00028	-.00894	.00656	-.00523	.00779	-.00249	-.00365	.00251	.00513	.00950
	-9	-.00814	-.01897	-.00071	-.00858	.00176	-.00574	-.00355	.00463	.00550	.01922
	-8	-.00415	-.01682	.00183	-.00267	.00342	-.00188	.00173	.01442	.01182	.03113
	-7	.00016	-.01315	.00619	-.00342	.00552	.00275	.00752	.01860	.01320	.03553
	-6	-.00746	-.00599	-.00386	-.00215	-.00612	.01023	.00132	.02619	.00737	.04611
	-5	-.01264	-.00041	-.01276	-.00162	-.01355	.01405	-.00041	.02792	.00632	.05056
	-4	-.01300	-.00554	-.01483	-.00577	-.01518	.01009	-.00247	.02847	.00399	.05505
	-3	-.01041	-.00452	-.01605	-.00645	-.01157	.01067	.00014	.03561	.01029	.06270
	-2	-.01090	.00110	-.02188	-.00201	-.01360	.01337	-.00795	.03832	.00778	.06464
	-1	-.01491	.00017	-.02814	.00177	-.01904	.01875	-.01334	.03823	.00895	.06600
	0	-.02530	.00155	-.03772	.00188	-.02547	.01878	-.01589	.04603	.00959	.07424

*Relative to announcement date for annual earnings

**Based on a weighted average of CAR+ and CAR-.

TABLE 2

Losses Associated With Each of the 4 Forecast Methods

	BJ		BR		F		GW	
	1976	1977	1976	1977	1976	1977	1976	1977
Loss*	.03497	.05869	.04731	.07236	.03506	.05546	.02548	.02821
Avg**	.0468		.0598		.0453		.0268	

*Based on composite CAR

**Average of CAR+, CAR- for both years.

TABLE 3

Forecast Methods Ranked Based on Loss

	1976	1977	Average
BJ	2	4	3
BR	4	3	4
F	3	2	2
GW	1	1	1

TABLE 4

Unweighted Cell Means for the Method Factor

		Year 1976	1977	Overall Average	Overall Rank
M	BJ	.4432	.5265	.4848	3
E	BR	.3902	.5265	.4432	4
T H	F	.4394	.5341	.4867	2
O D	GW	.4659	.6174	.5417	1

TABLE 5

Weighted ANOVA to Compare Forecast Methods

Panel 1 (cell means)

		1976	1977	Avg.	Rank
M	BJ	.4197	.5030	.4604	3
E T	BR	.3807	.5041	.4410	4
H	F	.4194	.6508	.4884	2
O D	GW	.4497	.6522	.5486	1

Panel 2 (ANOVA Table)

	Source	Demoninator	DFN	DFD	MS	F	Prob.
(1)	Year	Firm	1	526	1.543	18.575	.0000
(2)	Firm	--	526	--	.0831	--	--
(3)	Method	(2) x (3)	3	1578	.1793	7.968	.0000
(4)	(1) x (3)	(2) x (3)	3	1578	.0510	2.226	.0819
(5)	(2) x (3)	--	1578	--	.0225	--	--

TABLE 6

Pairwise Comparisons Between Individual Methods

Mean	BR .4410	BJ .4604	F .4884	GW .5486
	Difference between means			
BR		.0194	.0474**	.1076**
BJ			.028*	.0882**
F				.0602**

*Significant at $\alpha = .05$

**Significant at $\alpha = .01$

TABLE 7

Weighted Analysis of Variance Under Definition Two

Panel 1 (cell means)

		1976	1977	Avg.	Rank
METHOD	BJ	.555	.552	.554	4
	BR	.632	.578	.606	3
	F	.701	.575	.640	2
	GW	.641	.600	.650	1

Panel 2 (ANOVA Table)

	Source	Demoninator	DFN	DFD	MS	F	Prob.
(1)	Year	Firm	1	526	.1397	1.789	.1781
(2)	Firm	--	526	--	.0781	--	--
(3)	Method	(2) x (3)	3	1578	.1529	6.801	.0002
(4)	(1) x (3)	(2) x (3)	3	1578	.0848	3.77	.0104
(5)	(2) x (3)	--	1578	--	.0225	--	--

TABLE 8

Pairwise Comparison Between Individual Means Under Definition Two

Mean	BR .554	BJ .606	F .640	GW .650
	Difference between means			
BJ		.052**	.086**	.096**
BR			.034**	.044**
F				.01

*Significant at α = .01

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NOTES

[1]The reader is referred to the Grossman and Stiglitz [1976] paper for details relating to the assumptions and logic of their analysis.

[2]In the present study we exclude the constant term based on the evidence provided by Brown and Rozeff [1978] that this term is not significant.

[3]Schaffer's test is generally known to be the most conservative of a general class of paired tests available.

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